All About Feet:

Self-Guided Tour
Grades 3-6

MUSEUM
OF TEXAS TECH
UNIVERSITY

Theropod Footprint
Photo courtesy of Bill Mueller

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Museum of Texas Tech University
P.O. Box 41391
Lubbock, Texas 79409-3191
http://www.depts.ttu.edu/museumttu

The Museum of Texas Tech University

The Museum of Texas Tech University is an educational, scientific, cultural, and research element of Texas Tech University. It consists of several components: the main Museum building, the Moody Planetarium, the Natural Science Research Laboratory, the research and educational elements of the Lubbock Lake Landmark, and the Val Verde County research site.

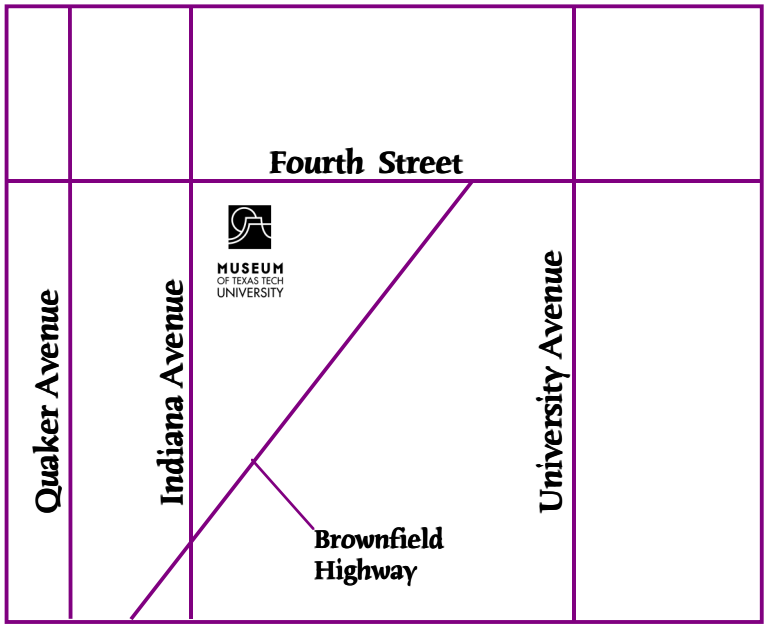
Museum of TTU
Photo Courtesy of Patrice Fay

Mission Statement

The mission of the Museum is to collect, preserve, interpret, and disseminate knowledge about natural and cultural material from Texas, the Southwest, and other regions related by natural history, heritage, and climate. The Museum's collections, exhibitions, programming, and research complement the diverse interests of Texas Tech and its role in public and professional education in local, state, national, and international communities. Through classroom instruction, practicum, and fieldwork, the Museum provides both theoretical and practical education. It is dedicated to acting as a responsible partner to Texas Tech and the community of museums.

Group Reservations

Reservations for touring the Museum are required, even for self-guided tours. Bookings must be made at least two weeks prior to your visit. At this time, you must reserve the Exploration Box if you will be using it during your visit.. Call (806) 742-2456 to reserve your tour time.



All About Feet Introduction

Designed to enhance the science curriculum of the TEKS, *All About Feet* explores the lives of dinosaurs through the footprints they left behind. Students will learn about different types of dinosaurs, how footprints are fossilized, what paleontologists can learn from trace fossils, and much more! This self-guided, teacher-led program includes supplemental materials, a pre-visit lesson, a Museum visit lesson and tour script, and post-visit activities. In addition, the program offers a Power Point presentation on CD to be used during the pre-visit lesson.

Background information, activities, and other supplemental materials are provided in this packet to help facilitate an informative and successful experience. It is strongly suggested that classes complete the pre-visit lesson plan and follow up with a post-visit activity after the Museum visit.

TEKS Standards Met

All About Feet was designed to supplement the Grades 3, 4 ,5 and 6 TEKS science curriculum. The following list, grouped by grade level, identifies TEKS standards this program meets:

Grade 3:

§ 112.5 (3.2) (A,B,C,D, & E) **§ 112.5 (3.4) (A & B)**

§ 112.5 (3.8) (A &B)

Grade 4:

§ 112.5 (4.2) (A,B,C,D, & E) **§ 112. 5 (4.4) (A & B)**

§ 112.5 (4.8) (A, B, & C) **§ 112.5 (4.10) (A & B)**

Grade 5:

§ 112.5 (5.2) (A,B,C,D, & E) **§ 112.5 (5.4) (A & B)**

§ 112.5 (5.9) (A,B, & C) **§ 112.5 (5.11) (A & B)**

Grade 6:

§ 112. 22 (2) (A,B,C,D, & E) **§ 112.22 (12) (A, B, & C)**

Teacher Discussion/Background Information

The following offers background information and topics for instruction and discussion. Name pronunciations and definitions can be located in the brochure: "A Changing World," included with this packet.

What is a dinosaur?

- Emerging during the Late Triassic Period (228 million years ago), dinosaurs ruled the Earth for over **160 million years.**
- At the end of the Cretaceous Period (65 million years ago), dinosaurs vanish from the fossil record (with the exception of birds).
- Theories abound as to why dinosaurs became extinct, however, very solid evidence points to the consequences of an **asteroid impact** causing the mass extinction of the dinosaurs.
- Dinosaurs belong to a group of reptiles known as **archosaurs** in which there are two lineages: one leading to crocodiles and one leading to birds. Archosaur means **"ruling reptile."** Archosaurs are defined by their antorbital fenestra. The antorbital fenestra is merely an extra hole in the skull. This hole is located in front of the eye (ant=before; orbit=eye; fenestra=window).
- Crocodilians, pterosaurs, and their extinct relatives are also classified as archosaurs…however, they are *not* dinosaurs.
- Dinosaurs are technically defined by their "perforated acetabulum," which simply means that they had a **hole in the middle of their pelvis.** No other animal on Earth has ever exhibited this feature.
- The evolution of a hole in the pelvis allowed dinosaurs to walk with their legs directly beneath them, as opposed to the sprawling condition of other reptiles.

"We are not dinosaurs!"

Commonly mistaken as dinosaurs, the following prehistoric animals are actually not dinosaurs at all:

1. Pterosaurs – These flying reptiles that lived during the Jurassic and Cretaceous Periods were not dinosaurs…the *were* related archosaurs.

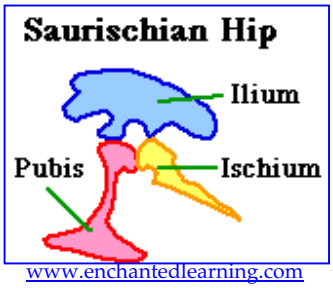
2. Dimetrodon – Commonly mistaken as a dinosaur, Dimetrodon (recognized by a large sail on its back) lived during the Permian Period and was actually a proto-mammal.

3. Plesiosaurs – Ancient marine reptiles such as plesiosaurs were not dinosaurs.

How Are Dinosaurs Classified?

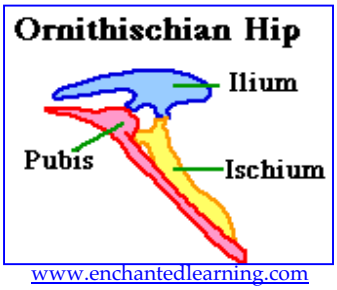
On the most basic level, dinosaurs are classified into two orders according to the general structure of their hip (notice the hole in the center of the pelvis):

1) The Saurischians **(lizard-hipped)**



www.enchantedlearning.com

2) The Ornithischians (**bird-hipped)**



www.enchantedlearning.com

Within these two orders, the major dinosaur suborders exist. Listed below are the suborders and examples of dinosaurs belonging to that suborder. Dinosaurs in **bold** indicate animals that are found in the Museum's galleries (species names are added for further identification).

SAURISCHIANS (lizard-hipped)

Suborders:

1) *THEROPODS* (carnivorous, intelligent, bipedal) Examples: ***Tyrannosaurus rex, Coelophysis bauri, Deinonychus antirrhopus***
2) *SAUROPODS* (giant herbivores, quadrupedal, herders) Examples: ***Camarasaurus grandis,*** *Apatosaurus*, *Diplodocus*
3) *PROSAUROPODS* (early Sauropod relatives, herbivores, some bipedal) Examples: *Plateosaurus*, *Massospondylus*, ***Mussaurus patagonicus***

ORNITHISCHIANS (bird-hipped)

Suborders:

1) *ORNITHOPODS* (herbivores, some bipedal, included duckbills) Examples: *Iguanodon*, ***Maiasaura peeblesorum***, ***Tenontosaurus tilletti***
2) *THYREOPHORA* (armored, quadrupedal, herbivores) Examples: *Stegosaurus*, *Ankylosaurus*, *Minmi*
3) MARGINOCEPHALIA (horned or thick skulled, quadrupedal, herbivores) Examples: ***Triceratops horridus***, *Pachycephalosaurus*, *Styracosaurus*

Are Birds Dinosaurs?

- Yes. Overwhelming evidence has led most scientists to agree that ***birds are the living descendents of dinosaurs.***
- Moreover, it should be noted when classifying birds within the animal kingdom, they should be classified as **reptiles.**
- Birds evolved from the Saurischian (lizard-hipped) line of dinosaurs. Despite the irony of not being classified with the Ornithischian (bird-hipped) dinosaurs, birds actually evolved from the theropod (Saurischian)

dinosaurs. The pelvis of the modern bird is an example of how **biological convergence** can occur, meaning, a similar physical characteristic can evolve independently within different group of animals that exhibit the same characteristic. Example: Birds, bats, and pterosaurs all developed wings for flight, but evolved wings independently from each other.

Paleontology

- Paleontology is the study of ancient life.
- Through the study of fossils, paleontology tells us about "the ecologies of the past, about evolution, and about our own place, as humans, in the world" (www.umcp.berkeley.edu).
- Paleontology is a multi-disciplined science incorporating aspects of biology, geology, ecology, computer science, museum science, mathematics, and many other academic disciplines.

Trace Fossils

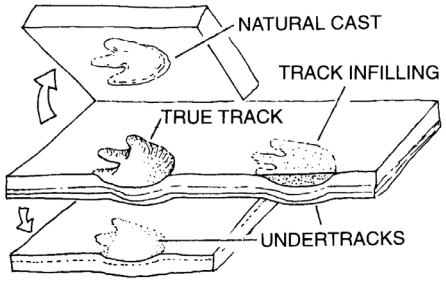
***T. rex* Footprints**
Main Gallery

- Fossils are any evidence of ancient life. Two major types of fossils exist: body fossils and trace fossils. **Body fossils** are preserved body parts of ancient organisms. Bones, plants, teeth, horns, and body armor are examples of body fossils.
- Dinosaur footprints and tracks are types of **trace fossils**. Trace fossils are any indirect evidence of ancient life that reflect some sort of behavior.
- Other types of trace fossils are eggs, nests, tooth marks, coprolites (fossilized dung), gastroliths (gizzard stones), burrows, and borings.
- **Paleoichnology** is the study of ancient plant and animal traces.
- Trace fossils are more abundant than body fossils. This is because one animal can leave behind many traces (eggs, nests, coprolites, footprints, etc.) but only one set of bones. Trace fossils are generally very well preserved, are excellent environmental indicators, and are often found in-situ (meaning they are found exactly where they were made/left originally).

Dinosaur Footprints

- A footprint is the impression of a foot into soft sediment. A fossilized footprint impression is also called a ***"true track," "mold,"*** or ***"the positive."***
- Fossil footprints occur when an organism steps into a moist surface (such as a shoreline). The impression that is left eventually dries. Once the footprint is dry it becomes more resistant to the effects of erosion. Eventually, a new flood will wash a new layer of sediment over the footprint. The buried footprint is now preserved beneath the protective layer of sediment.

- **Undertracks** or **"ghost tracks"** are also considered fossil footprints. As a foot sinks into a moist surface, pressure from the weight of the foot makes a less defined impression on layers of ground below the surface. These impressions are even more likely to preserve because they are already covered by layers of sediment. The infilling of a footprint by sediment which has turned to rock is called a "**natural cast.** " Casts are also called ***"the negative"*** and are also referred to as *"footprints."*

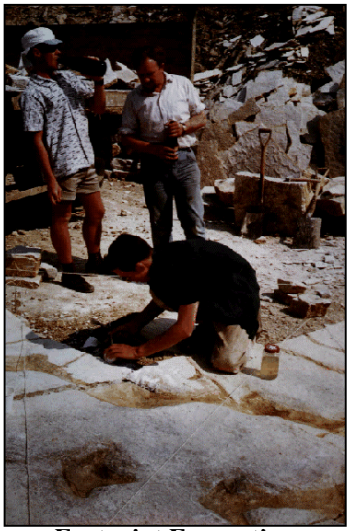


Footprint Fossil Terms
(*From Lockley, M. Tracking Dinosaurs*)

- Dinosaur **trackways** are two or more consecutive footprints(steps) belonging to a certain animal progressing in a given direction.
- Footprints and trackways can give us great insight into the activity of dinosaurs when they were living.
- Generally, scientists do not find dinosaur footprints in the same rocks that they find body fossils, because dinosaur footprints usually are preserved in acidic sediments that are not good for preserving bone.

More Footprint Facts:

- Dinosaur footprints are found in exposed layers of sedimentary rocks ranging in age from **230 million** years to **65 million** years old.
- Dinosaur footprints can be found on all seven continents with the exception of Antarctica.
- The majority of dinosaur footprints are found in mountains (including cliffs, slopes, and fallen blocks of rock). Dinosaur footprints are also commonly found in deserts, river valleys, quarries, and mines.
- Fossil footprints are excavated in a variety of ways:



Footprint Excavation
http://www.stone.uk.com/dinos

- ¬ Footprints are often found in rocks lying on the ground, which can easily be taken back to the lab.
- ¬ Footprints can be found by splitting rocks.
- ¬ Footprints can be excavated by hammering them out of the ground, boulders, or mountains.
- ¬ Some footprints or trackways (such as those found in large boulders or mountainsides) can not be excavated because it is too difficult or impossible to procure them (due to safety, weight, hazardous environments, etc.).
- ¬ Areas where trackways are particularly abundant or interesting are often designated as state parks or museums for all to enjoy.

- By studying the size, shape, and geologic age of a track scientists are able to suggest the type of dinosaur that made the track. Skeletal remains found nearby tracks also aid in this process.
- From dinosaur footprints, scientists can learn many things such as:
  - ¬ The bone structure of the foot, including the number of toes which touched the ground and which ones supported most of the animals' weight.
  - ¬ The skin structure and padding of dinosaur feet.
  - ¬ Whether the dinosaur was bipedal (walked on two legs) or quadrupedal (walked on four legs).
  - ¬ The speed and length of the dinosaur's stride.
  - ¬ The existence of dinosaur herds and stampedes.
  - ¬ Stalking behavior.
  - ¬ Other dinosaur activity and behavior.

Saurischian (lizard-hipped) Dinosaur Footprints

Theropods:

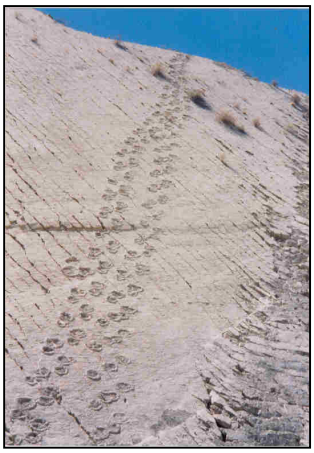
- Theropod dinosaurs (like *T. rex* and *Deinonychus antirrhopus*) had three toes that touched the ground. The fourth toe was placed higher up on the foot and did not touch the ground. This toe is called a hallux. Theropod dinosaurs, therefore, left behind three-toed footprints that are very similar to their descendants, birds.
- Theropod dinosaurs were "obligate bipeds" meaning they were obligated to walk on two feet.
- Theropod dinosaurs walked on their toes. This is called digitigrade. Other animals that walk on their toes are dogs and cats.

Theropod Footprint
http://hoopermusuem.earthsci.carleton.ca/

- Casts of Theropod footprints can be viewed in the Museum in both the Main Gallery (Main Display, *T. Rex* footprints) and the Dinosaur Hall (Case 11, *Acrocanthosaurus* footprints).

Sauropods:

- Sauropod dinosaurs (like *Apatosaurus* and *Camarasaurus*) had five toes, however, in their footprints we can only see toe definition in the hind feet (pes), not the front feet (manus). Sauropod footprints are very massive and globular in shape.
- Sauropod dinosaurs were obligate quadrupeds, meaning they had to walk on four feet.
- Sauropod trackways indicate that many of these animals traveled in herds.
- Casts of Sauropod footprints are located in the Dinosaur Hall (Case 11, *Pleurocoelus*; and Display 7, *Camarasaurus*).



Sauropod Trackway
www.earth.ox.ac.uk/

Sauropod Trackways illustrating herding behavior
www.gavinrymill.com/dinosaurs/tracks

Ornithischian (bird-hipped) Dinosaur Footprints

- The shape of Ornithischian dinosaur footprints varies depending on the type of dinosaur.
- Ornithopods generally leave three-toed footprints like theropods except that they are broader and shorter. Ornithopods were capable of leaving bipedal trackways, but were mostly facultative bipeds (meaning they could walk on two feet, but spent most of their time on four feet).
- Hadrosaurs (duckbill dinosaurs) left the most attributable trackways.
- Other types of Ornithischians like Ankylosaurs and Ceratopsians left four toed footprint impressions. These animals were quadrupedal.
- Casts of Ceratopsian footprints care located in the Main Gallery (Main Display, *Triceratops*).

Hadrosaur Footprint (glove for scale)
www.geology.gov.yk.ca/projects/other.html

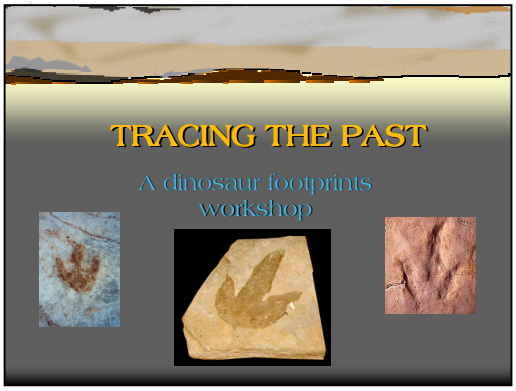
***Triceratops* Foot**
Museum of TTU

Pre-Visit Preparation

Provided below is a suggested Pre-Visit lesson plan designed to introduce students to dinosaurs and dinosaur footprints. You may choose to use this lesson plan or create your own. Throughout this packet, scripted dialogue/information that you may wish to use is italicized. Name pronunciations and definitions can be found in the enclosed brochure: "A Changing World: Dinosaurs, Diversity, and Drifting Continents."

Pre-Visit Lesson Plan: Tracing the Past

Grades: 3rd – 6th
Subject: Science
Topic: Dinosaur Footprints
Time: 1 hour 15 min.
Place: Classroom



Power Point Presentation: Tracing the Past

You will need the following materials:

- 10'x5' strip of butcher paper
- Jar of tempera paint (any color)
- 1 Paint Brush
- 1 Paint Tray
- Paper Towels
- Museum provided Power Point presentation
- Power Point projector, computer, and associated technology
- Supplemental packet (for handouts and worksheet see pp. 23-29).
- 11"x 14" construction paper
- Markers, pencils, crayons
- One expendable pair of flip-flops

Learning Objective: Students will learn about dinosaur feet and footprints.

Behavioral Objectives:
Cognitive: Students will learn about dinosaurs, how fossil footprints are made/preserved, types of dinosaur footprints, where fossil footprints are found, how they are excavated, and why we should study them.
Psychomotor: Students will practice drawing skills.
Affective: Students will appreciate the scientific value of trace fossils.

Skills: Communication, Independent Learning, Natural Sciences, Spatial Skills

Program Plan Format:

Preassessment: Ask questions about feet, dinosaurs, and dinosaur footprints. *How important are your feet? Think about what your feet allow you to do. Why do you think learning about dinosaur feet is important? What kinds of things can we learn from dinosaur feet and footprints? In the next few days we will be studying fossil footprints. We will be going to the Museum of Texas Tech University in the next few days to see some dinosaurs and some dinosaur footprints.*

Motivational Set: Conduct a demonstration showing how footprints reveal clues to the activities of animals. You will need a long piece of butcher paper roughly 10'x5'. You will also need an expendable pair of flip-flops, tempera paint (any color), a paintbrush, and a paint tray. Pour some paint into the paint tray and brush the bottoms of the flip-flops with the paint. Make sure to get a good coating of paint. Ask for a volunteer from the class to wear the flip-flops and make footprints on the butcher paper. Ask the rest of the class turn around and face the other end of the room (they must not look at the student making the footprints). Have your volunteer walk on the butcher paper. Tell the volunteer to do a series of activities: jump, turn in a circle, limp, hop on one foot, etc. Reapply the paint to the bottom of the shoes if needed. Once finished, have the class examine the footprints. Begin a class discussion about the footprints. Let the class try to guess what actions took place on the butcher paper. Feel free to circle on the butcher paper various prints that signify hops, circling, limping, etc.

New Learning: Give Power Point presentation provided with this packet, or work through the handouts of the slides in a class discussion. Have students fill in the "Tracing the Past" worksheet during the presentation.

Summary: Answer any questions about the presentation. Give answers to the questions on the worksheet that the students missed.

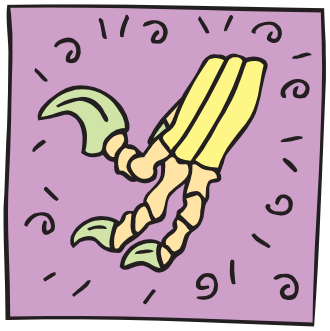
Application: Hand out the supplemental packet. The dinosaur family tree handout shows three types of dinosaur footprints that are circled. Have the students draw (preferably with pencil) these three types of footprints on a large 11"x14" piece of construction paper. Make sure they label what *general* type of dinosaur made this kind of footprint (for this exercise: Theropod, Sauropod, and Ceratopsian). While the students are drawing, note that the Theropods and Sauropods were the lizard-hipped dinosaurs and the Ceratopsian (horned dinosaur) was a type of bird-hipped dinosaur. Let the students write below their label whether the footprint belonged to a lizard-hipped or bird-hipped dinosaur. Students can trace their pencil outlines with marker and color in the footprints if they wish (use markers or crayons). Once the footprints have been drawn and labeled, have the student draw around the footprint things the dinosaur could have stepped on or around. Suggestions include rocks, dirt, puddles, insects, other smaller animals, and plants. Have the students share their drawings with the class and decorate the room with the drawings.

Conclusion: Summarize the major concepts of the lesson. *Remember we will be going to the Museum to see many dinosaurs and some of the types of footprints that they made.*

Museum visit

All About Feet Lesson Plan

The following is a general lesson plan created for your visit to the Museum. Upon arrival, please sign in at the Guard's kiosk located in the Main Lobby. Clipboards and pencils will be provided for your class upon arrival (all worksheets must be completed on the clipboard and please - No pens in the gallery).



Title: All About Feet
Grades: 3rd – 6th
Place: Main Gallery and Dino Hall:
Museum of Texas Tech University
Time: 1 hour
Group Size: 30 students
Subject: Natural Science
Topic: Dinosaur Footprints

You will need the following materials:

- ¬ Clipboards (provided by the Museum)
- ¬ Pencils (provided by the Museum)
- ¬ "How Fast Was *T. rex* Traveling" and "Tracking Dinosaurs" Worksheets (see pp. 30 – 35). Photocopy one per student.
- ¬ Exploration Box (rulers, measuring tape, calculator, Camarasaurus and Deinonychus claw casts, Camarasaurus laminated footprint). (provided by the Museum).

Learning Objective: Students will learn about dinosaurs through examining dinosaur remains and the fossilized footprints they left behind.

Behavioral Objectives:
Cognitive: Students will learn what types of information can be obtained about dinosaurs from studying their fossil footprints (such as speed, herding, and predatory behaviors).
Affective: Students will appreciate the important contribution made by dinosaur feet and footprints to our understanding of the past.

Skills: Communication, Critical and Creative Thinking, Natural Sciences, Numeracy

Program Procedure:
Pre-Visit Lesson – Please complete the suggested pre-visit lesson plan (or one of your own) before your visit to the Museum.

Motivational Set (10 min.) – Before leaving the school, tell the students that they have a special task to complete before their visit to the Museum. *Once you have stepped off the bus, line up in a single-file line. As we begin our walk toward the museum, I want you to silently count how many footsteps it takes to get to the front door. Remember your number and keep it to yourself.* Have your class step to the side of the building for a moment and share their answers. See if the class can make any guesses as to why the number of footsteps varied to differing degrees. (possible answers include: some kids are taller and/or walk faster/slower). *How many steps do you think it would have taken T. rex to get to the Museum? How many steps do you think it would have taken Velociraptor?* After this activity, enter the Museum in an orderly fashion. Make sure to sign in your group at the guard's kiosk and collect the clipboards and pencils provided by the guards. Remind the students to only write on the worksheets they have and not to lean or write on anything in the galleries.

Note: Remind students what a fossil is. Tell them that they are going to be seeing casts of fossils in the Dinosaur Hall. Let the students know that most of the dinosaurs in the Dino Hall are not made of real bone. The footprints in the hall are also not "real," but exact casts as well. Exact casts (made of resin) are on display because dinosaur fossils are too fragile to exhibit. Real bones need to be kept in safe conditions where scientists can preserve and conduct research on them.

New Learning (45 min.) - Explore Main Gallery and Dino Hall. Tour the displays and cases which relate to dinosaur feet and footprints. You, the teacher, will begin the tour in the Main Gallery in front of the *Tyrannosaurus rex* and *Triceratops* display. Discuss the dinosaurs and footprints. Complete the worksheets, **"How Fast Was *T. rex* Traveling?"** as a group (pp.1-3), discuss the answers. Have the students work on the last page **"Trackway Interpretation"** individually for a few minutes. Students should finish this page for homework.

Begin the **"Tracking Dinosaurs"** worksheet (students should fill in the information for the *T. rex* and the *Triceratops*). This worksheet may be completed in groups or individually. Move your class into the Dino Hall. Again, discuss the dinosaurs, the types of footprints they left behind, and what their footprints tell us about the lives of dinosaurs. Encourage the class to discuss answers. Have your class complete the **"Tracking Dinosaurs"** worksheet in the Dino Hall. A tour script has been written specifically for this program and is provided within this packet. All italicized print is provided for you, the teacher, to say to your class.

Conclusion (5 min.) – Summarize the main concepts of the lesson plan: dinosaur footprints and what they tell scientists about the lives of dinosaurs. Ask if there are any questions. Return to school. Complete post-visit activities.

Museum Visit:
Suggested Tour Script

The following is a script of a tour you can conduct that was designed specifically for this program. As a reminder, scripted dialogue is written in italics. You are free to allow students to view all cases/displays, however, only some are pertinent to this program. The tour begins in the Main Gallery, which is located directly behind the lobby. The *Tyrannosaurus rex* and *Triceratops horridus* casts are found in the center of the Gallery. The rest of the suggested tour (in the Dino Hall) can be referenced by case number on the back of the enclosed brochure: *A Changing World: Dinosaurs, Diversity, and Drifting Continents*. All tour activities are underlined (including activities using the Exploration Box).

Tour Script:

1) Main Gallery – *Triceratops* and *T. rex* Display: Begin your tour in the Main Gallery in front of the *Tyrannosaurus rex* and *Triceratops horridus* display. Start your tour with a brief review of your pre-visit lesson. *Today we are going to take a look at dinosaurs and the footprints they left behind. Fossil footprints are trace fossils. Remember, **trace fossils** are any **indirect** evidence of ancient life, as opposed to direct evidence such as body fossils (ex. fossil bones). Name some other types of trace fossils. Trace fossils are more abundant than body fossils. Why? Fossil footprints are very useful to paleontologists. What types of information about dinosaurs do fossil footprints provide?*

***Triceratops* and *T. rex* Display:**
Main Gallery

*We are going to be able to experience first-hand how fossil footprints can give us tremendous insight into the lives of dinosaurs. All of the dinosaurs and dinosaur footprints we will see today are exact casts (replicas) of the original bone and footprints. Behind us we see a confrontation about to occur between two dinosaurs that lived during the **Late Cretaceous** Period (72-65 million years ago): **Triceratops horridus** and **Tyrannosaurus rex.** It is important to be aware however, that this confrontation scenario probably never occurred exactly this way. Evidence suggests that*

Tyrannosaurus did prey upon Triceratops, however it probably did not charge the Triceratops head on. Why do you think this would be true? What would be a better way for T. rex to attack Triceratops? Why? [It would be more advantageous to attack Triceratops from the side or behind so as to avoid the dangerous horns on his head.]

Triceratops was a Ceratopsian dinosaur that had three horns on its massive head (one of the largest skulls ever discovered). The horns were used for both competition among males and for protection. Triceratops was ***a quadrupedal herbivore****. What does this mean?* Triceratops walked on four legs and ate plants. *Take a look now at the footprints that this Triceratops was leaving behind. Describe them. Describe the foot. How many toes does Triceratops have? How many toe prints can you see? Which footprints are from the front feet and which are from the back feet?* Hint: Look at the left rear leg placement next to the footprint in front of it. *The front feet are called the* ***manu****s and the back feet are called the* ***pes****. Quadrupedal animals usually walk by moving the right manus and the left pes at the same time – alternating with each step. Often in quadrupedal dinosaurs you will see that the manus footprints are smaller than the pes. This is because they carried less weight in the front of their bodies than in the rear.* Have the students get down on all fours and try "walking" this way."

Now lead your group over to the other side of the display to view the *T. rex* footprints. *In front of us is Tyrannosaurus rex, which means " Tyrant Lizard King." These animals were* ***bipedal carnivores****. What does this mean? Yes, it means that they walked on two legs and ate meat. T. rex grew to be up to 40 feet long and 20 feet high. T. rex is a* ***theropod*** *dinosaur. What kind of footprints did theropod dinosaurs leave behind? Theropods, including T. rex, had bird-like feet and left behind three-toed footprints. Describe the foot of T. rex. Notice that T. rex had three toes that touched the ground and a fourth toe located higher on the foot. This is called a hallux. T. rex walked on its toes, this is called digitigrade.*

T. rex **"Footprints"**
Main Gallery

Describe the T. rex footprints (both on the floor and in the display). Look at the footprints on the floor. Estimate how many of you can fit into a T-Rex footprint. See how many members of your class can fit into one *T. rex* footprint. Use all three footprints and then count how many students fit into each of the three footprints. *Considering how large T. rex is, how fast do you think he/she could travel? Scientists can calculate how fast an animal can move by studying the limbs of the animal. Generally, the longer the tibia or lower leg bone (when compared to the femur or upper leg bone) the faster the animal. Paleontologists suggest that T. rex could have reached a maximum speed of 20 miles per hour.*

Another way of estimating the speed of animals is through studying their footprints. Luckily, since dinosaurs left behind fossil footprints, we can estimate the speed that they were traveling at the time they made the footprints. Today we are going to complete an exercise that will give us an estimation of the speed that the Museum's T. rex was traveling when it made these footprints. Before we begin, how fast do you think that this

T-Rex would have been traveling, considering it was getting ready to attack its prey? Write that number down and we will see later how accurate our estimation was. Conduct the exercise, " How Fast Was *T. rex* Traveling?" as a class. Select students to measure the footprint and stride of the *T. rex*. Make sure all measurements are converted to meters. Complete the first three pages of the exercise, but let the students work on the last page: "Trackway Interpretation" on their own. Let them work for a few minutes and then continue the tour. The worksheet should be finished for homework. A measuring tape, rulers, and a calculator may be found in your Exploration Box. **Make sure to make photocopies of all worksheets and bring them with you to the Museum (the Museum will not provide copies).** At this time have the students start filling out their "Tracking Dinosaurs" worksheet. They should complete the *T. rex* and *Triceratops* columns.

Camarasaurus and Juvenile – Dino Hall
Photo Courtesy of Bill Mueller

2. Dino Hall: *Camarasaurus* - Giant of the Jurassic (Display 7): Now lead your class into the Dino Hall. Gather your students around the center display of the ***Camarasaurus grandis*** and ***Camarasaurus lentis*** (juvenile). *What kind of dinosaurs do we see here? This is a Camarasaurus and juvenile Camarasaurus. These dinosaurs were sauropods, giant quadrupedal herbivores that lived during the Jurassic period (208 –145 million years ago). Take a look at the footprints they have left behind. Do you remember how footprints are fossilized? Yes, footprints are fossilized after an animal has stepped into a moist surface. Once the wet footprint dries, it becomes hardened and less susceptible to the effects of erosion. The footprint is buried by new layers of sediment (from a flood or tide) which helps preserve it. Geologic forces over time bring the footprint to the surface.*

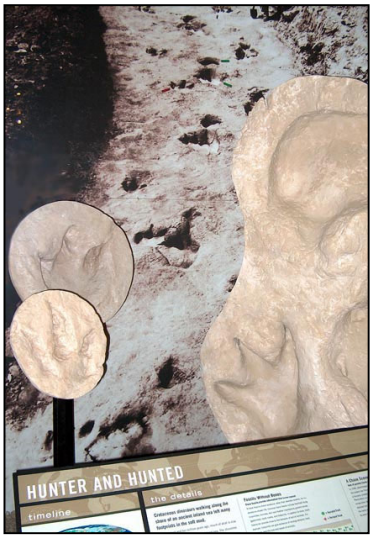
Now describe the footprints. How are they different from the T. rex and the Triceratops footprints? How are they alike? They are very globular and round in shape. Notice that like the Triceratops footprints, the footprints made by the front feet(manus) are smaller than those made by the rear feet (pes). This display illustrates what footprints look like when they are first made and what they look like just a few moments later. Notice how you can see the toe definition clearly in all of the "fresh prints." Count the number of toe prints you can see. Look at the Camarasaurus foot. How many toes can you count? Now look at the "older" footprints. How are they different? Can you see any toe prints in any of these footprints? No. This is because the ground is extremely wet and water is covering a majority of the print. Take out the *Camarasaurus* claw from your Exploration Box and pass it around the group. Have the students compare the claw to the size of their hands. Bring the class around to

***Camarasaurus* footprints**
Dino Hall

Display 10 : Tooth and Claw. *Here we see* ***Deinonychus antirrhopus****, a theropod dinosaur, in the middle of an attack. A juvenile duckbill dinosaur* ***Tenontosaurus tilletti*** *is the prey. Notice the sharp "killing claw" on Deinonychus (whose name means "Terrible Claw").* Take out the casts of the *Deinonychus* claws from the Exploration Box. Pass them around the group and have the students compare the theropod claw to the sauropod claw. Discuss the differences. Bring your group back over to the *Camarasaurus* display. Now take out the laminated *Camarasaurus* footprint. Lay the footprint out on the floor. See how many students can fit in the footprint. Discuss how many more or less students fit compared to the *T. rex* footprint.

If you were a paleontologist, what else could you learn about Camarasaurus by examining these footprints? First, we are able to see that Camarasaurus juveniles traveled with their parents. The smaller footprints following the larger footprints provide evidence that this occurred. Secondly, this fact would lead a paleontologist to consider that Camarasaurus was a herder (was social and traveled in groups). Indeed, Camarasaurus footprints found across the United States indicate that they were herders. From fossil footprints, paleontologists have determined that many sauropod dinosaurs were herders. Have the students fill out the *Camarasaurus* category in their "Tracking Dinosaurs" worksheet.

3) Dino Hall – Hunter and Hunted (Case 11):



Hunter and Hunted Case
Dino Hall

Bring your class over to Case 11. The entire class may have difficulty fitting in front of the case. It is suggested that some students sit in front of the case while others stand behind them. *Think back to our lesson about dinosaur footprints. Where are dinosaur footprints found? Did you know that one of the most famous dinosaur trackway sites is found here in Texas? Along the* ***Paluxy River*** *(southeast of Ft. Worth, near Glen Rose) hundreds of dinosaur tracks have been discovered. During the Cretaceous period (around 110 million years ago) east Texas was covered by a sea. The shoreline of this sea ran north to south. The area of Glen Rose was located along this shoreline. Dinosaurs walking along the shoreline left footprints that eventually fossilized. Erosion caused by the currents of the Paluxy River has exposed these footprints.*

Take a look at the background picture in this case. This is a photograph of dinosaur trackways found along the Paluxy River, one of the most famous dinosaur trackways known. Why? Describe the photograph. How many trackways do you see? What is unusual about them? They are parallel to each other and were made by two very different animals. ***R.T. Bird****, the paleontologist that discovered the trackways, proposed that the set of tracks reveal a stalking and attack sequence. From the footprints and knowledge of dinosaurs that lived in the area at that time, paleontologists have concluded that the*

predator was probably a theropod named ***Acrocanthosaurus atokensis*** *and the prey was a large sauropod dinosaur named* ***Pleurocoelus nanus****. Bones of both dinosaurs have been found in nearby sediments. Notice in the picture how the theropod prints are running parallel to the sauropod prints. Moreover, notice how the theropod prints get closer and closer to the sauropod prints. Now look at the green and red arrows on the photograph. The arrows indicate where some paleontologists think the theropod actually attacked the sauropod. The two consecutive right footprints or "hop" suggest that the theropod actually clung to its victim for a short distance. After the attack, the tracks indicate that the sauropod dragged its back right foot as if injured.*

Some paleontologists like Jim Farlow, however, think that the footprints are too ambiguous to come to this conclusion. Farlow thinks that if the theropod "hopped" during the attack, the second right footprint should be distorted (because of the impact from the hop). Farlow thinks that the theropod was following the sauropod to presumably attack it at some point. What do you think? If you were a paleontologist how would you interpret these tracks? Discuss responses.

Paluxy River Footprints
Dino Hall

Take a look at the casts of the footprints in the case. The large footprints are casts from the sauropod dinosaur Pleurocoelus taken from the Paluxy River location. These footprints are very characteristic of sauropod footprints. The front foot (manus) is rounded and has no toe prints. How does the rear foot (pes) compare? How many toe prints can you count? There are five impressions in the pes where the toes were placed. Now notice the theropod track to the left. This track is from the theropod dinosaur Acrocanthosaurus, and illustrates how close it came to the sauropod. The two individual casts in the left of the case are also theropod dinosaur footprints. Students should complete the rest of their worksheet "Tracking Dinosaurs."

Conclude your tour with a brief summary of dinosaur footprints and what we can learn from them: *Dinosaur footprints give us a glimpse back in time to the activities of dinosaurs. Through fossil footprints, paleontologists are able to learn much more about dinosaur behavior than can be learned from body fossils. Think about some of the things we have learned today about dinosaurs just from studying fossil footprints. We can estimate the speed that dinosaurs were traveling, we can learn about herding behaviors, and we can learn about predator and prey scenarios. These are just a few of the insights that can be gained from studying trace fossils.* If time allows have the students tour the rest of the Dino Hall paying close attention to the feet of the dinosaurs.

Note: After your tour, please complete the Exploration Box inventory sheet located inside the Exploration Box. Please return the inventory to the Museum's Education Department. Thanks!

Post-visit Activities

The following are suggested Post-Museum visit activities. It is recommended that your class complete at least one of the following to maximize the Museum experience and the educational potential of the overall program.

#1 – Footprint Detectives
Students can become paleontologists for the day with this interactive activity. First, have students create their own dinosaur footprints drawing (with construction paper, pencils, and markers). This drawing should illustrate a dinosaur trackway that the student imagines finding while out on a prospecting expedition. The student may choose to draw more than one trackway, but stress that the trackway should tell a story about what the dinosaur was doing at the time the trackway was made.

Each student should write a brief paragraph describing what kind of dinosaur(s) made the trackway and what it was doing at that the time the footprint was made. Once the drawings are completed, mix them up and hand them back out making sure that each student is given another student's drawing. Now it is their turn to be a paleo-detective! Students should examine the drawings and write down what type of dinosaur(s) (theropod, sauropod, etc.) made the trackway(s). Then they should try to determine what was happening when the footprint was made. Have each student present the drawing and their findings to the class. Then have the original artist verify if his/her detective work was accurate!

#2 – Footprint Casts
This activity is a simple way for your students to learn the basics of making a cast of a footprint. Paleontologists make casts of footprints for many reasons. Sometimes they cannot take the footprint back to the lab, so they will make a cast that can carry back. Sometimes museums will request a cast of a certain footprint for exhibition or research purposes. With this activity, students can learn a simplified version of the casting technique. They will use their own footprints however, instead of dinosaur footprints.

For each student you will need:
- ¬ 2 ice cream containers or buckets (1 gallon)
- ¬ 6 cups of damp sand
- ¬ 3 cups of Plaster of Paris or other plaster mix
- ¬ water
- ¬ tempera or acrylic paints
- ¬ paint brushes

Step 1: Firmly pack the sand in the bottom of one of the ice cream containers.
Step 2: Have each student **carefully** place one foot in the container and step **lightly** into the sand, leaving a footprint.
Step 3: In the other container, mix water with the plaster. When ready, pour the plaster over the top of the sand, filling in the footprint.
Step 4: Leave footprint overnight to fully dry.
Step 5: Remove the hardened plaster from the container and dust off any loose sand.
Step 6: Have the students paint the cast to give it a natural look.

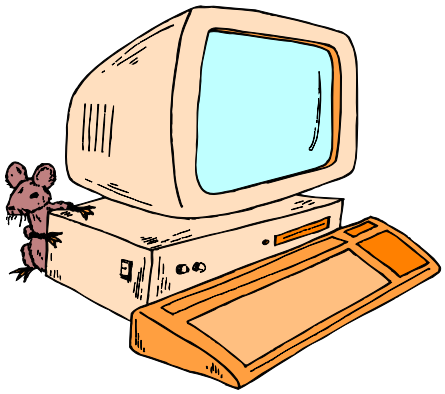
#3 - Dino Footprints Word Search
Reinforce new footprint vocabulary with this fun word search! (p.36 of this packet)

#4 – Footprint Magnets
Students can make magnets of their favorite dinosaur footprint shape in this fun activity.

You will need:
- ¬ Funky foam (1 sheet per 8 students)
- ¬ Magnetic tape strips (1 inch strip per student)
- ¬ Scissors
- ¬ Markers

Cut each funky foam sheet into eight sections. Hand out one piece per student. Have each student draw his or her favorite dinosaur footprint on the piece of foam and cut it out. Cut a 1 inch long strip of magnetic tape per student. Students then peel off the backing of the strip and stick it on to the back of the foam footprint. Use the markers to decorate the magnets and you're done!

#5 – Footprint Surfing



Depending on whether your class or library has internet access, have students research a dinosaur footprints website. You can conduct this activity as a class or students may work individually (at school or at home). It is important to stress that students exercise caution when gathering information on the internet. The most reliable sources are those associated with Universities/Colleges, Scholarly Journals, and Professional Societies. Students may begin their research with search engines such as "Google," or they may use the following websites as a jumping off point:
http://news.nationalgeographic.com/news/2003/03/0307_030310_dinotracks.html
http://news.nationalgeographic.com/kids/2004/08/dinotracks.html
www.enchantedlearning.com/subjects/dinosaurs/dinotemplates/footprint/shtml
http://news.bbc.co.uk/1/hi/scotland/2210169.stm
http://palaeo.gly.bris.ac.uk/Palaeofiles/Tracks/default.html

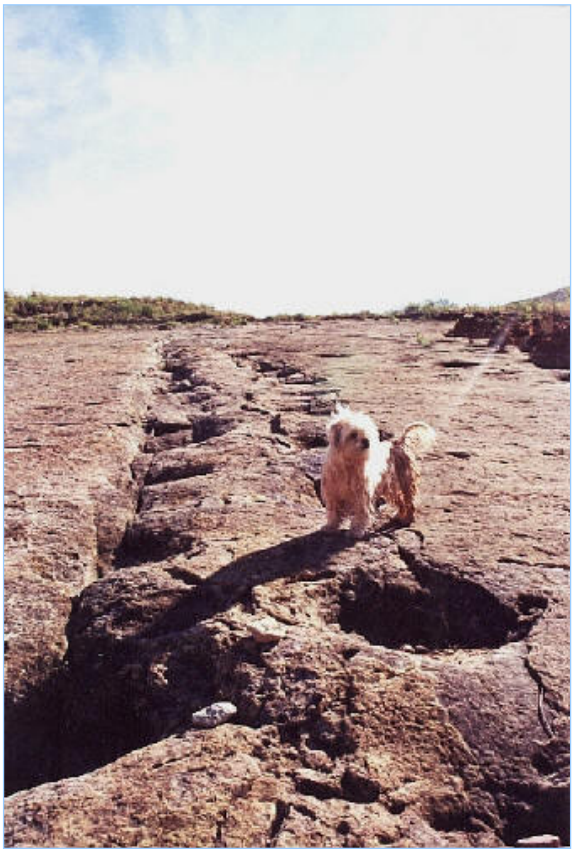
Resources on the World Wide Web

Dinosaur State Park, Rocky Hill, CT – www.dinosaurstatepark.org
Dinosaur Valley State Park, Glen Rose, TX –
www.tpwd.state.tx.us/park/dinosaur
Emory University –
http://www.emory.edu/COLLEGE/ENVS/ichnology/dinotracks.htm
Enchanted Learning – www.enchantedlearning.com
Jurassic Park Institute – www.jpinstitute.com/index.jsp
Museum of Paleontology, U. of California, Berkeley – www. ucmp.berkeley.edu
Museum of Texas Tech University – http://www.depts.ttu.edu/museumttu/
National Geographic – www.nationalgeographic.com
Nature – http://www.nature.com/nature
Nova Scotia Museum of Natural History –
http://museum.gov.ns.ca/mnh/nature/tracefossils/english/sections/whatare.html
Scientific American – www.sciam.com
Society of Vertebrate Paleontology – http://vertpaleo.org
Royal BC Museum –
http://www.royalbcmuseum.bc.ca/programs/dinos/making_tracks.html
University of Bristol –
http://palaeo.gly.bris.ac.uk/Palaeofiles/Tracks/default.html

Bibliography

The Complete Dinosaur. Farlow, James O. & Brett-Surman, M.K. 1997. Indiana U. Press: Bloomington.
Dinosaur Tracks and Traces. Gillette, David D. and Lockley, Martin G. 1989. Cambridge U. Press: Cambridge.
Dinosaurs: A Global View. Czerkas, Sylvia J. & Czerkas, Steven A. 1996. Barnes & Noble: Spain.
Encyclopedia of Dinosaurs. Currie, Philip J. & Padian, Kevin. 1997. San Diego Press: San Diego.
Tracking Dinosaurs: A New Look At An Ancient World. Lockley, Martin. 1991. Cambridge U. Press: Cambridge.

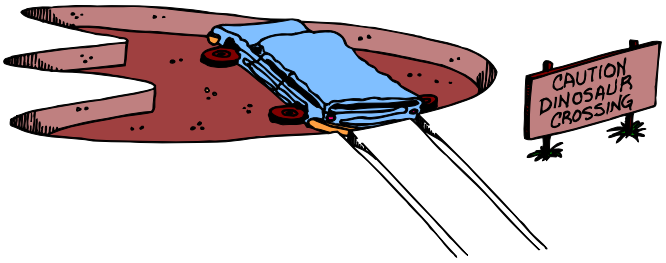
Supplemental Materials



www.rhymer.net/New%20Folder/dinodog.htm

Name: _____

Tracing the Past: Dinosaur Footprints



Directions: Follow along with the Power Point presentation and fill in the answers as you go. After each fill-in the blank statement, a slide number is given. This is the slide number on which the answer is found.

1) Dinosaurs can be classified into two orders:

the _____ and the _____.

(slide 1)

2) Dinosaurs lived during the _____ era. (slide 2)

3) Dinosaurs lived on the Earth for a duration of _____

years. (slide 2)

4) Dinosaur footprints help us learn many things about dinosaurs.

For example, we can learn whether a dinosaur walked on _____

legs (Bipedal) or _____ legs (Quadrupedal). We can also

learn about the _____ and the _____ of its

stride, as well as the existence of dinosaur herds and stampedes. (slide 4)

5) Theropods left _____ toed footprint impressions (slide 8)

6) Sauropods had _____ toes, but we can only see toe prints in the _____, not the manus. (slide 9)

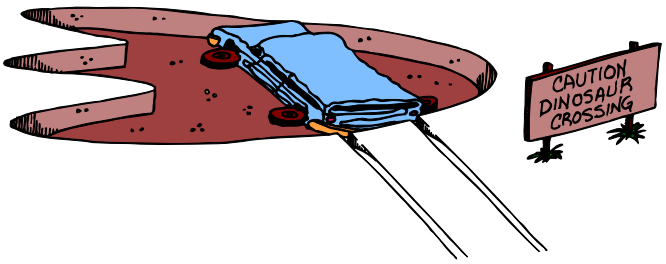
7) The shape of Ornithischian tracks _____ on the type of dinosaur. (slide 10).

8) After a wet footprint _____, it can be preserved for millions of years. This occurs when a new flood brings in new sediment depositing the next layer of earth. The new layer buries and preserves the footprint. (slide 12)

9) Fossil footprints can be found in _____, cliffs, _____, mines, and _____. They are found in all seven continents except _____. (slide 13)

Name: _____

Tracing the Past: Dinosaur Footprints Key



Directions: Follow along with the Power Point presentation and fill in the answers as you go. After each fill-in the blank statement, a slide number is given. This is the slide number on which the answer is found.

1) Dinosaurs can be classified into two orders:

the _____Bird Hipped_____ and the ___Lizard Hipped_____.

(slide 1)

2) Dinosaurs lived during the ____Mesozoic_____ era. (slide 2)

3) Dinosaurs lived on the Earth for a duration of _163__million__

years. (slide 2)

4) Dinosaur footprints help us learn many things about dinosaurs.

For example, we can learn whether a dinosaur walked on ___two____

legs (Bipedal) or ___four____ legs (Quadrupedal). We can also

learn about the _____speed_____ and the _____length_____ of its

stride, as well as the existence of dinosaur herds and stampedes. (slide 4)

5) Theropods left ___three_____ toed footprint impressions (slide 8)

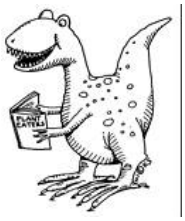
6) Sauropods had _____five_____ toes, but we can only see toe prints in the _____pes_____, not the manus. (slide 9)

7) The shape of Ornithischian tracks ___depends____ on the type of dinosaur. (slide 10).

8) After a wet footprint ____dries_____, it can be preserved for millions of years. This occurs when a new flood brings in new sediment depositing the next layer of earth. The new layer buries and preserves the footprint. (slide 12)

9) Fossil footprints can be found in _____mountains_____, cliffs, ___quarries_____, mines, and __river valleys_. They are found in all seven continents except ____Antarctica_____. (slide 13)

A Dinosaur Footprints Glossary



Biped: An animal that walks on its two hind feet.

Cast: The fossilized infilling of a footprint. Also referred to as the "negative."

Digit: An individual finger or toe.

Digitigrade: Walking on the digits only. Tyrannosaurus Rex was digitigrade.

Footprint: The impression made by any foot (front or back) in soft sediment. A footprint becomes a fossil when it is turned into rock.

Ichnology: The study of trace fossils…such as fossil footprints.

Manus: Latin: hand. Refers to the front feet in four-footed animals – not necessarily used for walking.

Mold: The fossilized *impression* of a footprint. Also referred to as the "positive."

Pes: Latin: foot. Refers to the hind feet in four-footed animals.

Plantigrade: Walking with the digits flat and part or all of the ankle and wrist also on the ground. Humans are plantigrade.

Quadruped: An animal that walks on all fours.

Substrate: The ground on which animals walk or progress.

Trackway: Two or more consecutive footprints (steps) belonging to a particular animal progressing in a given direction.

Underprint: The impression made by a footprint on an underlying layer of strata. May closely resemble a true footprint or be quite indistinct.

Source: Lockley, Martin. *Tracking Dinosaurs: A New Look At An Ancient World. Cambridge: U of Cambridge Press, 1991.*

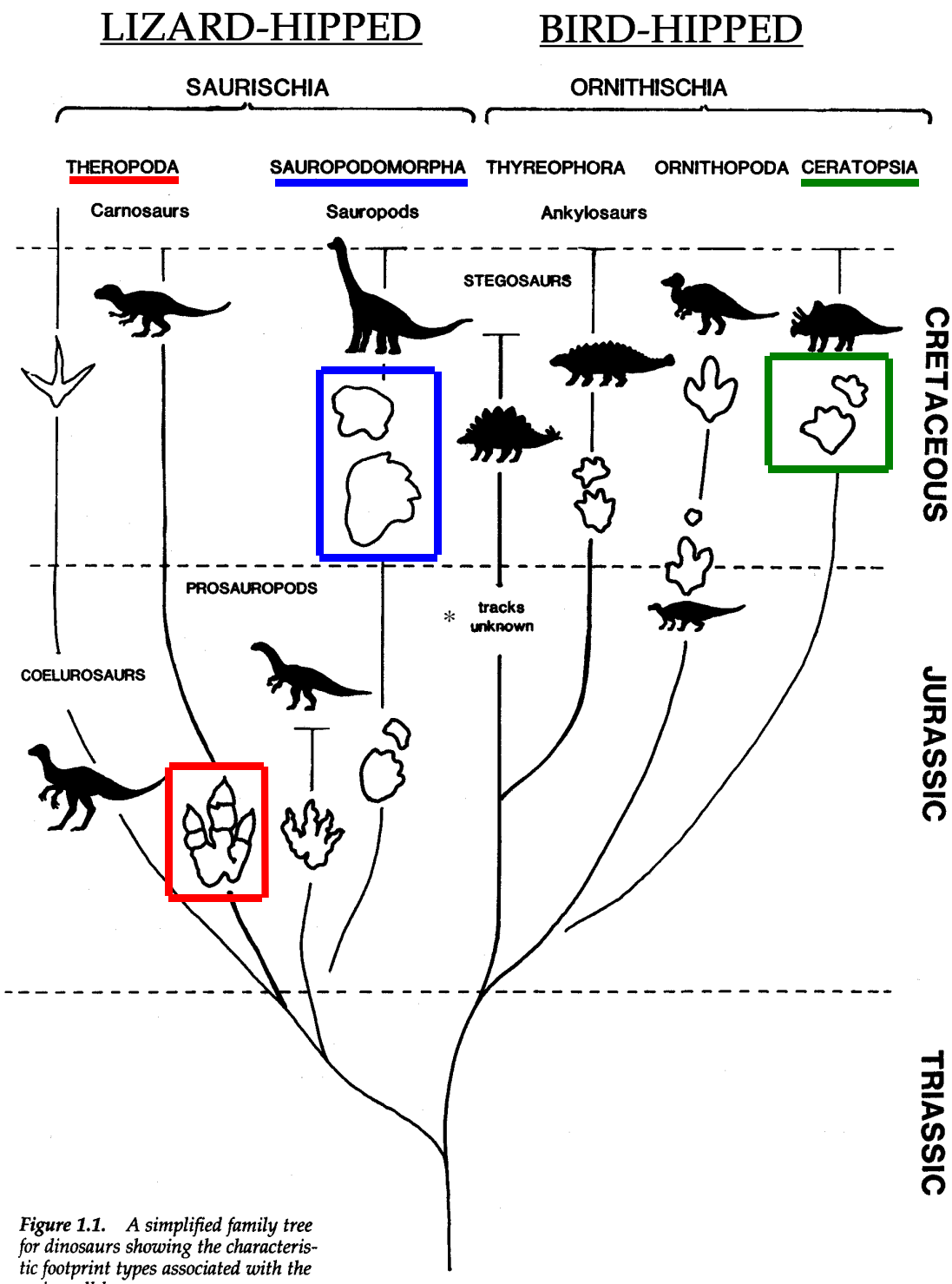


Figure 1.1. *A simplified family tree for dinosaurs showing the characteristic footprint types associated with the main well-known groups.*

Source: Lockley, Martin. *Tracking Dinosaurs: A New Look At An Ancient World. Cambridge: U of Cambridge Press*

*** The only known Stegosaurus tracks were found at a sacred Aboriginal site in Australia. They were stolen in 1996. Today, only one footprint has been recovered..**

Tracking Dinosaurs

Directions: **Footprints of each dinosaur in this exercise can be found in the Museum's galleries. Examine the footprints and please check each box that describes the listed dinosaur. Use only the footprints (and pictures of the footprints when applicable) to decide on your answers. What do the footprints say about these dinosaurs? (Hint: When deciding on how many toes are in the footprint, some dinosaurs require checking more than one box).**

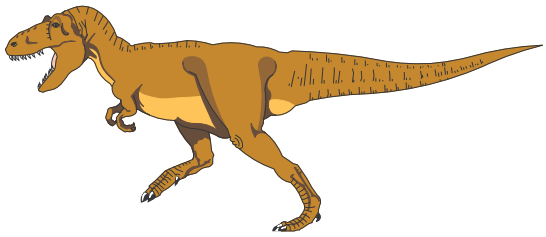
Characteristic	T. rex	Triceratops	Camarasaurus	Acrocanthosaurus	Pleurocoelus
Theropod					
Sauropod					
Ornithopod					
Ceratopsian					
No toes in footprint					
Three toes in footprint					
Four toes in footprint					
Five toes in footprint					
Small manus footprints/ large pes footprints					
Bipedal					
Quadrupedal					
Herder					
Predator					
Prey					
Injured					

Tracking Dinosaurs Key

Directions: **Footprints of each dinosaur in this exercise can be found in the Museum's galleries. Examine the footprints and please check each box that describes the listed dinosaur. Use only the footprints (and pictures of footprints when applicable) to decide on your answers. What do the footprints say about these dinosaurs? (Hint: When deciding on how many toes are in the footprint, some dinosaurs require checking more than one box).**

Characteristic	T. rex	Triceratops	Camarasaurus	Acrocanthosaurus	Pleurocoelus
Theropod	X			X	
Sauropod			X		X
Ornithopod					
Ceratopsian		X			
No toes in footprint					manus
Three toes in footprint	X			X	
Four toes in footprint		X			
Five toes in footprint			X		pes
Small manus footprints/ large pes footprints		X	X		X
Bipedal	X			X	
Quadrupedal		X	X		X
Herder			X		X
Predator	X			X	
Prey		X			X
Injured					X

How Fast Was *Tyrannosaurus rex* Traveling?



Fossil footprints yield tremendous information about the lives of dinosaurs. For example, you can tell how fast an animal is traveling by taking measurements from its footprints (even fossilized ones)! Since dinosaurs left fossilized footprints, you can also estimate how fast they were going at the time they left the footprints.

Directions:
Complete the steps listed below with your class to estimate the speed the Museum's *Tyrannosaurus rex* was traveling at the time the footprints were made. You will notice accurately sized *T. rex* footprints on the Museum floor. Use these footprints to help complete this exercise. Use a tape measure, ruler, and calculator (if needed) to solve the problem.
Before you begin remember: you **must** write all of your answers in **meters.**

1 meter =100 centimeters (approximately 3 feet). Example: 25 centimeters(cm) = .25 meters (m)

More Examples:

- 37 cm = .37 m
- 86 cm = .86 m
- 116 cm = 1.16 m
- 264 cm = 2.64 m
-

A Conversion Exercise: Practicing With Decimal Places

1) 18 cm = _____m

2) 176 cm = _____m

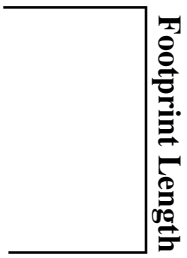
3) 43 cm = _____m

4) 322 cm = _____m

Now you are ready to estimate the speed of the Museum's *Tyrannosaurus rex!*

STEP 1 : Footprint Length

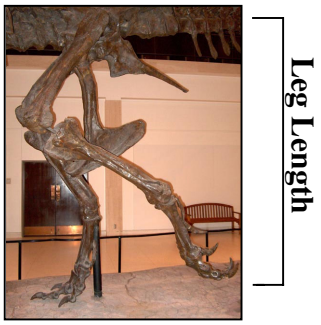
Measure the length of a *Tyrannosaurus rex* footprint on the Museum floor.



Write your answer here: _____m

STEP 2: Leg Length
Multiply the answer you got in **Step 1** by 5. Footprint length multiplied by **5** equals **leg length**. Use a calculator if you need help multiplying the decimals.

_____ x 5 = _____m

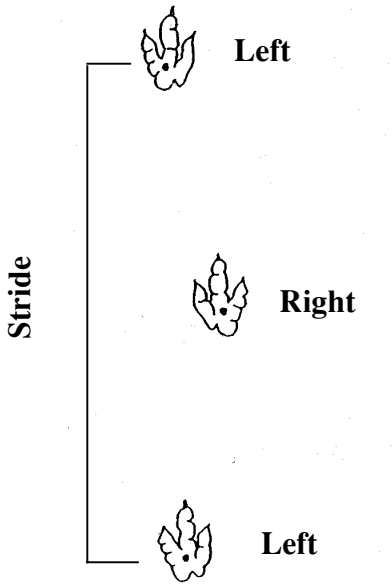


STEP 3: Stride Length
Stride length is the distance from a point on a footprint to the same point on the next print of the **same** foot.

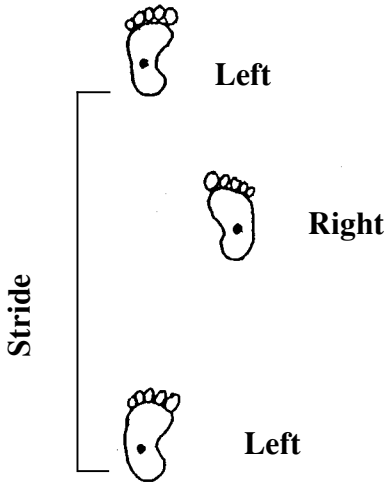
T. rex Stride Length _____m

The two following diagrams illustrate how to measure stride length.

<u>*T. rex* Stride</u>



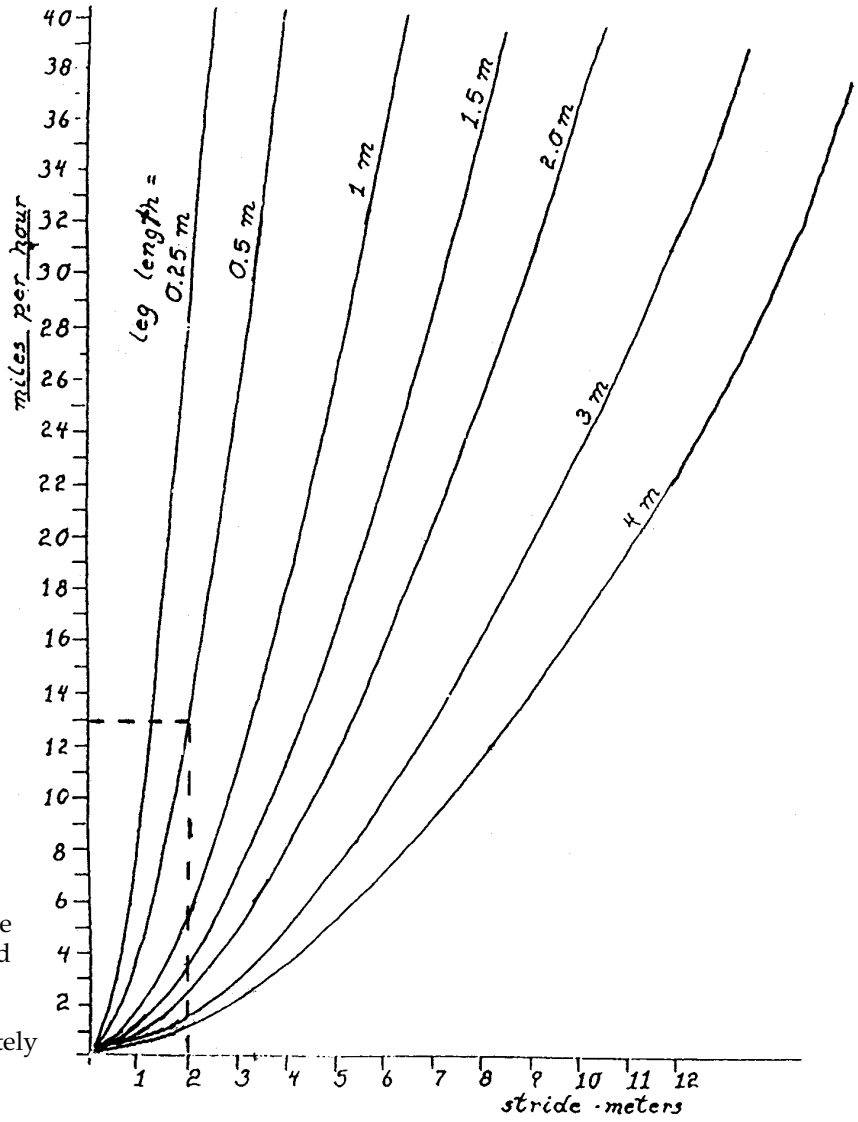
<u>Human Stride</u>



STEP 4: Speed

Using the graph below, calculate the speed of the animal.

A. Start on the bottom line at the number closest to that which you measured for **stride length** in **STEP 3.**
B. Using a **ruler**, draw a line straight up until it intersects the **leg length** closest to that which you calculated in **STEP 2.**
C. Now draw a line to the left. This will tell you the **speed** at which the animal was traveling.



* For example, if my dog "Rex" has a stride length of 2 meters and a leg length of 0.5 meters, his speed would be approximately 13 miles per hour.

Remember, this method will work for dogs, cats, lizards, mice, parents, kangaroos, and any other animal that leaves behind footprints. Just go out and measure **footprint lengths** and **stride lengths** in the mud and try this at home. Have Fun!

Name_____ *All About Feet*

Trackway Interpretation

1. Describe the shape and size of the *T. rex* footprint. Make a sketch.

2. How fast was the *T. rex* traveling?_____mph.

3. In the Museum's display, the *T. rex* is about to attack the *Triceratops*. How did this knowledge affect your interpretation of the *T-Rex* footprints and the capabilities of *T. rex*?

4. From the data collected during the speed experiment, what conclusions can you draw about this *T. rex*?

5. As a scientist, can you confidently propose that all *T. rexes*, on average, traveled at this speed during an attack? Why?

A Dinosaur Footprints Word Search

DIRECTIONS: SEARCH FOR THE VOCABULARY WORDS BELOW. ONCE YOU FIND THE WORD, CIRCLE IT. YOU MAY FIND WORDS DIAGONALLY, FORWARDS, AND/OR BACKWARDS.

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G L D H U V P T O R T G S A U R O P O D
B X A A W U A A C N Z I O V V E D T F U
X P O N O R U L T I Y W G L Q H Z T N D
G U P W T N I R P T O O F I O E N D K E
U S D S A I W Z I H T M O L D N E X C P
X X B F H C G A A O O H L S V R H T J U
R U E N A E Q R K P X M E T P C C C T R
S B J N K N S U A O Z S S R N E I P I D
D I G I T I G R A D E U I A O N S Q W A
D E P I B F T T S G E N W C A P L S Z U
O K L H O L P M M D T A B K T P O A V Q
L B O S W L U J S J X M R W Z K L D B F
Z H S I D X M Y A P U D F A X L W F N C
S I Q P C B R N E M W B Y Y O R M B V Z
L N P X F T G Y D A L L T R Q D B B Y D
Y H C P B P G W A O Y S K Z C J D U X P
X N B J E D Y N G M A M P J L H Q E I N
G T V S X I R W R C R Z X U S T H A D K
W U L X U I Y M X Z F W D D K V D U V M

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CAST
DIGIT
DIGITIGRADE
FOOTPRINT
FOSSIL
ICHNOLOGY
MANUS
MOLD
ORNITHOPOD
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PLANTIGRADE
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THEROPOD
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B X A A W U A A C N Z I O V V E D T F U
X P O N O R U L T I Y W G L Q H Z T N D
G U P W T N I R P T O O F I O E N D K E
U S D S A I W Z I H T M O L D N E X C P
X X B F H C G A A O O H L S V R H T J U
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S B J N K N S U A O Z S S R N E I P I D
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D E P I B F T T S G E N W C A P L S Z U
O K L H O L P M M D T A B K T P O A V Q
L B O S W L U J S J X M R W Z K L D B F
Z H S I D X M Y A P U D F A X L W F N C
S I Q P C B R N E M W B Y Y O R M B V Z
L N P X F T G Y D A L L T R Q D B B Y D
Y H C P B P G W A O Y S K Z C J D U X P
X N B J E D Y N G M A M P J L H Q E I N
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